

I. Introduction and Case Description

The goal of this case is to familiarize the trainee with the mechanics of using the TCM Wind Tool (2006 version) in order to produce a meteorologically consistent gridded surface wind forecast. The case centers around the changing track of Tropical Storm (TS) Arlene on 10-11 June 2005 and its operational impact on how the wind field must be edited to remain meteorologically consistent. Delivery of the case is divided into two parts: (1) A one:one discussion with the trainee regarding the use of the tool and associated details and (2) Reviewing the actual case and running the TCM Wind Tool to populate and eventually edit the GFE surface winds for the 10 June 2005 – 4 PM CDT Tropical Prediction Center (TPC) Advisory 10. Total delivery time should be under 1.5 hours. ***Note*** GFE must be installed on WES in order to deliver this case (see Part II)..

Topics discussed in Part I include:

- TCM Wind Tool Mechanics
- Future NDFD Wind Definitions
- GFE Wind Editing – Best Practices
- GFE - TCM Winds Process Limitations
- GenerateCyclone Tool
- Wind Gust Grid Production

The meteorological background needed to deliver Part-IV is rather simple. Beginning on 10 June 2005 with TPC Advisory 8 (4 AM CDT – see Fig. 1 below), Arlene was forecast to make landfall on the Mississippi Gulf Coast after midnight on 11 June.

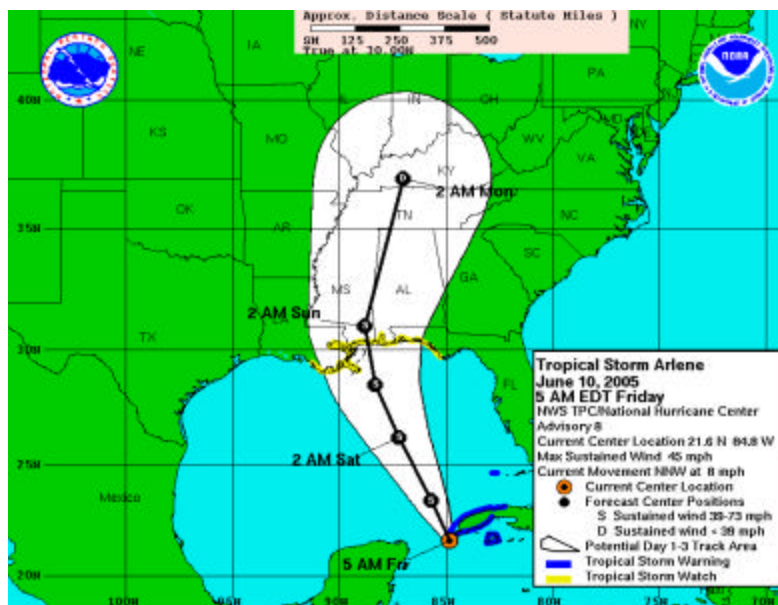


Figure 1

By 10 AM CDT (or Advisory 9 shown in Fig. 2), the forecast track was shifted so that landfall was near Mobile Bay and earlier in time. By 4 PM CDT (Advisory 10, see Fig. 3), the forecast track was shifted further east to make landfall near Pensacola, FL

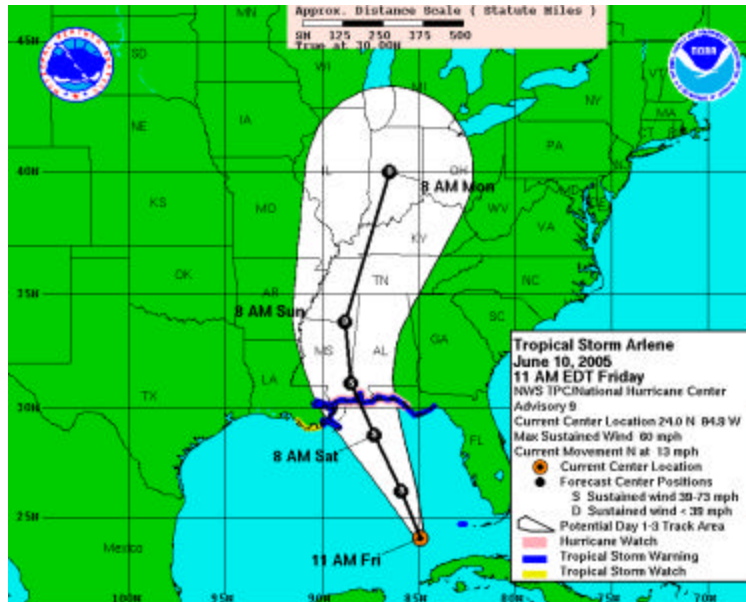


Figure 2

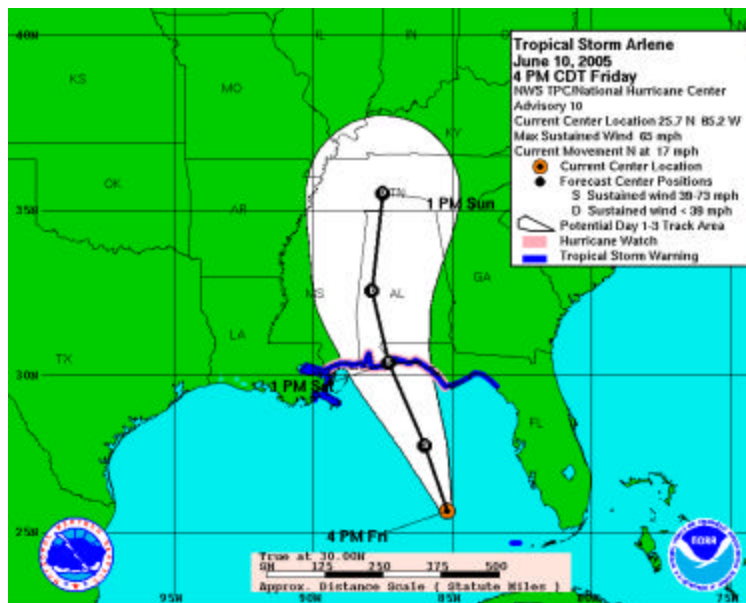


Figure 3

II. Setting up WES and GFE for Case Delivery

Other than having GFE installed on WES, there is not much to do in order to prepare for case delivery. **You do need to do the following:**

- The AWIPS DVD containing all necessary data (including model files) for 10 June 2005 has been provided.
- You must have GFE and the TCM SmartTool installed. You need to pre-read the TCM SmartTool Documentation.
- You must have TCP Advisories 8, 9 and 10 (included).
- Covert the case to DRT format for 10 June 2005 1930-2130 UTC.
- Start GFE after starting WES to run the case from 1930-2130 UTC. You will note that the GFE time clock is controlled by WES. If you do not pause the simulation just before 2130 UTC, GFE will continue running additional SMARTINITs past the desired time. **The case is delivered while paused around 2115-2125 UTC.**

III. Case Delivery

- A. **One:One Discussion** - TCMWind Wind Tool Mechanics and Best Practices for Populating and Editing GFE Wind Grids (as of May 2006 – see below). **Note – WFO MOB found this very fruitful to conduct Part-I with numerous forecasters as a round-table style discussion.**

1) NDFD Wind Definitions – Have to know what you are forecasting for.

- **Wind Speed** – 10 m wind, 2 minute mean wind measured at the top of the hour (*hh+58 to hh+00*).
- **Wind Gusts** – 10 m maximum 3 sec mean wind gust measured within 2 minutes at the top of the hour (*hh+58 to hh+00*). Wind gusts =13 kt show up as 0 values in the wind grids.
- **Wind direction** – 10 m wind direction using 36 points of a compass measured at the top of the hour (*no time interval given as of 05/2006...*)

2) *TCMWind* Tool Mechanics:

- How to run the tool
- Selecting a product to decode
- Background Model
- Eye diameter and radius
- 34 kt wind radii at 3, 4 and 5 days
- Decreasing winds over land
- Make Grids over Selected Time Only

a) **Background Model** - Since you are placing TPC's vortex into the direct model output, it seems obvious to pick the model that most closely matches TPCs forecast, thus resulting in the least amount of editing for you. Time shifting and moving edited areas while preparing the background field can both help to reduce additional edits.

b) **Eye Diameter** – TPC will report an observed eye diameter in the TCM bulletin and will use the value to calculate the radius of maximum wind according to:

$$RMW = (D_{eye} / 2) + 8$$

- *RWM will be used throughout the 5 day forecast. If you do not override it will use value in TCM bulletin.*

c) **34 kt wind radii at 3, 4 and 5 days** – Beyond 72 h, the TCM bulletin only defines a center location and maximum sustained winds at 24 h intervals. To better define the spatial extent use the sliders to set the Days 3-5 radii.

d) **Decreasing winds over Land** – The scale ranges from -20% to +50%. Negative values actually increase winds over land (note that we will never use this).

e) **Make Grids over Selected Time Only** – In short, if you want the tool to operate your wind grids on a shorter time interval than the TPC forecast (i.e., what you select in the GFE Grid Manager), then select 'YES.' Otherwise, the tool will run over the full time specified in the bulletin.

3) GFE Wind Editing – Best Practices

a) Overview:

- Populating - (i.e., running the tool)
- Performing Wind Edits
- Coordinate
- Edit Again (if necessary)
- Save and Publish to Official

b) Component Details:

i) **Populate**

- **Run tool over ‘Selected Times Only’** (i.e., a specified time interval) or over a full time range covered by the TCM Wind Bulletin. I would strive to destroy as little as possible since time is precious. The tool will return hourly wind grids based on the correct TC vortex translation speed for each consecutive 12 h period.
- **Background Model** – Having a meteorologically representative background field is critical. The bottom line is that it can save you numerous manual edits! Your population choices are **ETA80**, **GFS80** and **‘Fcst.’** Since **‘Fcst’** is an option, then essentially anything we have available can be saved as **‘Fcst.’** You may find it necessary to move grids in time (timeshift) or cut and move in space. If the model solution is right on, then go with it! For the best results, you will likely still have to edit winds over land and water (i.e., thinking through the processes) BEFORE you insert the vortex.
- **Wind Reduction over Land** - The friction force is one factor that reduces the winds over land. However, depending upon the characteristics of the vertical stability profile, higher momentum air may be allowed to be transferred to the surface, thereby reducing the amount of wind deductions that you would normally expect due to the friction force. I would start with decreasing winds over land by about 15-20% and go from there. It is TC dependent and we really need some research in our area in order to determine what typical reductions may be given some of our past events.

ii) Performing Wind Edits –

- **“Getting the Bang for Your Buck!”** – In this step, we want to get the most for our money given the time we spend editing! **Therefore, while not in Inner-Site Coordination (ISC) mode, I recommend going to the grid prior to the TC entering your coastal waters and working your way forward in time from that point. Providing the mesoscale details in our own area is what this is all about.** The High Impact Grid Forecaster (HIGF) performing this function sets the tone for all other products that flow forth and can help to prevent meteorological inconsistencies! **Having a nice GFE color curve for wind**

speeds also helps because you can readily see your edits!!!

- **Remembering Maximum Wind Caps** – Per policy, the following wind caps apply. Remember these (see below) when editing the wind grids.
 - **00-24 h** - up to TPC wind maximum
 - **25-72 h** - up to 100 kt (or up to TPC wind maximum if <101 kt).
 - **73-120 h** - up to 64 kt (or up to TPC wind maximum if <65 kt)
 - **121-168 h** - 30 kt maximum
- The *TCMWind* Tool accounts for these. Again, having a nice GFE color curve for wind speeds will move the process along more efficiently.
- **Vortex Contraction over land** – When the TC vortex moves over land it will encounter friction and associated mass convergence, and thus, will begin to fill and contract. Ensure the TC vortex realistically contracts over land. This may be critical, if at one 12 h period the vortex had not yet made landfall, but in the next 12h period the vortex is well inland. Having land-only and water-only GFE edit areas readily available makes the whole process more efficient time-wise and can also improve the accuracy of your value-added edits.
- **TC Vortex Blending with Ambient Flow** – Assuming you have chosen the best background model field (or ‘*Fcst*’) that results in the potential least amount of work, then you may need to perform edits along the periphery of the TC vortex where the Rankine combined vortex tails off non-linearly into the potential vortex flow region. I use an edit area for this and then smooth the heck out of it. Again, if the storm engulfs your area then this will be less of an issue.
- **Useful GFE Edit functionalities (just a few)** –
 - **Vector Edit Mode w/Pencil Tool** – speed only (direction constant); direction only (speed constant). Can also limit pencil tool radius of influence.

- **Cap Vector** – This is awesome! With edit areas employed (or without), you can specify a ceiling or a floor for wind speeds. You simply type in your minimum or maximum caps. At the end of the editing process, this is also helpful to make sure you have not exceeded the TPC caps.
- **Toggle Edit Area** – This takes the inverse of the edit area you originally drew. For example, you draw around the vortex, say the 34 kt isopleths, if you use this then you would talk to all grid points outside of this area. This is very useful when combine with the cap vector tool (previously mentioned above).
- **Move/Copy Tool** – This allows you to cut away an area of winds and move it somewhere else spatially while time is constant. This is useful when you are working on your background Field.

iii) Coordinate – It is worth re-iteration that coordination occurs after making human value-added edits. Thus, Step 2 would take place without inner-site coordination grids being turned on. You may find it helpful to remember the following:

- If our CWFA is ‘dead-center’ for landfall (e.g., Ivan 2004), then surrounding WFOs have an obligation to match to us (as we can do little to coordinate when a very large diameter TC vortex engulfs our area). Vice versa is the case (e.g., Katrina) when the TC vortex is centered on another WFO’s CWFA and we are ‘fringe.’
- Hypothetically, our neighbors are using the same tool as us and are also constrained to the same maximum wind value caps.

iv) Edit Again - Essentially, Steps 2 and 3 would be repeated until the forecast is made meteorologically consistent!

v) Save and Publish to Official – As it implies. You are done!

4) GFE-TCM Process Limitations -

- a. Low Temporal Resolution TCM** – It is quite apparent that TPC needs to “internally” provide WFOs with more forecast points. The

tool can only crudely translate the TC with 12 h average translation speeds. The problem is exacerbated when a TC vortex at one 12h forecast period has not made landfall, and the next 12h forecast point places the TC vortex well inland.

- b. **ISC Nightmare!** – Of course, it is easy to see that if one office is trying to coordinate hourly grids multiplied by how many hours they are affected by the TCM, then things get cumbersome in a hurry and during a period when time is precious. This naturally causes the WFOs to want to run the TCM Wind Tool and add few significant meteorological edits (which our users have come to expect). When this happens, I personally resort to making the most significant edits when the TC is expected to affect my area. When our WFO is on the fringe, then the coordination nightmare is lessened somewhat.
 - c. **Maximum Wind Caps** – Although these are now policy, it is still a problem for WFOs tasked with producing gridded wind forecasts. We must remain both cognizant and vigilant of this fact!
- 5) **Generate Cyclone Tool** – The *GenerateCyclone* Tool is to be used for tropical depressions, as there are some significant differences between it and the *TCMWind* Tool.
- 6) **Wind Gust Grids** – Suggest using a 30% multiplier. Dave Sharp and Pablo Santos have both done some work in this area and they say it works well. We need to refine this based on our own data (simple but needed project for someone). May want to run the ‘Cap Vector’ Tool w/ceiling option to ensure wind gusts do not exceed a certain value.

B. GFE TCM Wind Editing Exercise

*****NOTE*** Read this to forecaster before proceeding to forecasts. Give them handouts of TPC Advisories 8-10)**

- **Situation** – It is 10 June 2005 at 4 PM (21 Z). You are the day shift forecaster. A Tropical Storm Warning is in effect. On the 10 AM CDT Advisory, Tropical Storm Arlene, with maximum sustained winds of 60 mph, was located just north of the western tip of Cuba and was moving to the north at 13 mph. Arlene is forecast to make landfall as a tropical storm near Mobile Bay sometime between very late Saturday afternoon to mid-evening. Her track has been shifted significantly to the east since the 4 AM advisory which previously had the storm making landfall over Harrison County, MS just after midnight Sunday. You have just poured over your grids all day based on this track and have just issued all of your products. **SURPRISE!!!!** The new TCM comes in just minutes after you issued your entire package and the new landfall location is very near Pensacola, FL and has been moved to Saturday afternoon at 1 PM!

Now, both a Tropical Storm Warning and a Hurricane Watch is in effect. Arlene's speed has been increased to 17 mph and is now forecast to be just shy of a hurricane (i.e., 60 kt at landfall). Based on the points from the TPC Conference Call, you knew this would cause some changes to the grids, but **NOT THIS MUCH!!!**

- **Tasks (discuss each below as 1:1 with trainee):**

1. You have decided for continuity's sake, that you better stay and update the GFE winds for the latest TPC Advisory while the on-coming shift gets briefed and settles in. **This is the maintenance of situational awareness.** This will require re-issuance of the zones because forecast wind directions have changed significantly. Ask them what they would do at this point. What is their initial strategy? Discuss as necessary. You may be able to correct some bad habits and learn from great past practices.
2. **Examine vortex details** - Demonstrate how to run the TCM Wind Tool (for TONIGHT... TOMORROW and TOMORROW NIGHT using a zero wind direction and speed background field (so the vortex can be seen with no influence from the background field). When the tool is finished, make 3h wide grids (e.g., 00-, 03-, 06 UTC) using the middle-click grid stretch function. While showing these to the trainee, point out how the numerous meteorological discontinuities in how the TCM Wind Tool depicts the vortex according to the wind radii in the advisory [**Note-** It is 'eye-opening' for the forecaster to see how the text gets translated into a gridded forecast and it sets the tones for edits to be made. Our forecasters really loved seeing this!].
3. **Preparing the Best Background Field Possible** – After Step 2, forecasters will now realize they must have a strategy. It starts with the best possible background field (so as to reduce un-necessary edits **AFTER** the TCM Tool inserts the vortex.
 - You will now use D2D to view various model storm tracks (from both the 1200 and 1800 UTC runs using the ETA80 and GFS80). Examine the MSLP and winds. You will note that the 1200 UTC GFS80 has the best track spatially, but it needs to be time-shifted to reflect the latest landfall.
 - While in GFE (***NOTE*** - you are now done with D2D):
 - Populate the wind grids with the GFS 80 and time shift grids 12h to the left (making an earlier landfall).
 - Next, go to the time nearest landfall (11 June - 18 UTC) define an edit area and move the vortex in space to the exact location of landfall.
 - Since you time-shifted the grids by 12 h, night went into day (and vice). It is helpful to have 'land-only' and

‘water-only’ edit areas in order to adjust the wind field magnitude. In this case, all time periods need upward adjusting over both land and water. Winds are simply too light (and way too light over land).

- At this point, you should have the best background field possible before inserting the vortex via the TCM Wind Tool. These simple steps taken at this level should provide for enhanced meteorological consistency (and note the forecaster is still required to think through the processes) and cuts down on later required manual edits. Do not forget to interpolate to hourly grids and save to FCST.

4. **Run the TCM Tool with Finalized Background Field** – Run the TCM Tool with the following inputs:

- **Selected Times Only** -> 10 June 00 UTC - 12 June 12 UTC
- **Eye Diameter =5 n mi** – not really necessary since a tropical storm (but anything less than 5 n mi gives you a clear cut center to look at.
- **Reduce wind over land = 17%**

5. **After the TCM Tool successfully runs, make all of the 1 h grids into 3 h grids** (beginning with 00 UTC in the TONIGHT period and going through 06 UTC Sunday). ***NOTE*** - This may not be necessary if your GFE is configured for 3 h wind grids as the maximum temporal resolution.

6. **View the output and discuss with forecaster.** You should start by zooming in on the vortex at advisory times. Discuss what edits will now need to be made in order to make the forecast appear meteorologically consistent.

7. **Begin performing wind edits using some of the best practices previously described.** There are no ISC grids (ISC should be turned off at this stage anyway). Trainee will need to use aforementioned best practices in order to make the vortex look meteorologically realistic, while adding local value above and beyond that of the TPC forecast. **[The forecaster will edit five 3h wind grids surrounding landfall. It is wise to save the initial TCM Wind Tool output and drop them into adjacent wind grid boxes for comparison after edits are made].**

Some things to think about include :

- Blending the vortex into the potential vortex flow region

- Giving detail within radius of maximum winds
 - Preserving prescribed wind radii values throughout various quadrants
 - Showing detail as vortex crosses coastline
 - Showing proper decrease of maximum winds as vortex moves inland (to name a few).
8. **Allow the Forecaster to make meteorological edits** to the five wind grids described above.
 9. **Discuss meteorological edits** and re-emphasis best practices. Note that this is a great time to teach a forecaster new tricks since they are in a mindset to find the most efficient way out of the presented problem.
 10. **When finished, remind them that in the real world they should save, publish to official and run scripts** to send to NDFD, send *netCDF* and generate and send *.png* files to SRH since this is considered a forecast update.

C. Post Evaluation Questions (best verbally one:one with SOO). **Please adapt these for your station's needs. SOO would really be wise to take notes and consolidate responses for future use.**

- What did you learn from this process?
- Would not having 3h GFE winds (as maximum temporal resolution) not cut down on the coordination nightmare?
- Did you grasp the concept that 12h TC vortex translation speeds are what sets this tool apart from basic linear interpolation?
- Do you feel this type of training has (or will) change your job performance?
- What would you change, if you could change anything in this process (or about the tool itself)?